CLAIMS

1. A magnetic memory device comprising:

a read line to which read current is passed;

first and second write lines disposed separately from the read line so that write current can be passed in two ways to each of the first and second write lines, where a parallel portion in which the first and second write lines extend parallel with each other is formed by bending at least one of the first and second write lines; and

a magnetoresistive device having a magneto-sensitive layer whose magnetization direction changes according to a magnetic field applied, and disposed in the parallel portion,

wherein at least one of the first and second write lines is formed in a loop shape so as to include a bent portion and first and second portions connecting the bent portion and both ends,

the magnetization direction of the magneto-sensitive layer changes according to a magnetic field generated by write current flowing in the parallel portion, and information is written.

2. A magnetic memory device according to claim 1, wherein the parallel portion is formed by bending one of the first and second portions into a rectangular wave shape or a trapezoid wave shape.

3. A magnetic memory device according to claim 1, wherein the parallel portion is formed by bending both of the first and second portions into a rectangular wave shape or a trapezoid wave shape.

4. A magnetic memory device according to claim 3, wherein the direction of bending the first portion and that of the second portion coincide with each other.

5. A magnetic memory device according to claim 2, wherein a pair of magnetoresistive devices construct one memory cell.

6. A magnetic memory device according to claim 1, wherein both of the first and second write lines are formed in a loop shape,

one of the first and second write lines is bent so that both of the first and second portions have a rectangular wave shape or a trapezoid wave shape, and the bending direction of the first portion and that of the second portion coincide with each other, thereby forming four parallel portions in a pair of first and second write lines,

a pair of magnetoresistive devices disposed in the two parallel portions provided in the first portion construct a memory cell belonging to a first group, and

a pair of magnetoresistive devices disposed in the two parallel portions provided in the second portion construct a memory cell belonging to a second group.

7. A magnetic memory device according to claim 6, further comprising a write logic controller for receiving address information indicating the first or second group to which a memory cell to be written belongs and write information to be written, and selecting the direction of write current supplied to the first and second write lines on the basis of the address information and the write information.

8. A magnetic memory device according to claim 1, further comprising a write current drive circuit including: a current direction controller to which both ends of a write line having a loop shape as one of the first and second write lines are connected and which controls the direction of the write current in the write line in two ways; and a current amount controller for controlling the amount of write current in the write line to a constant value, and supplying the write current to the write line.

9. A magnetic memory device according to claim 7, further comprising a write current drive circuit including: a current direction controller to which both ends of a write line having a loop shape as one of the first and second write lines are connected and which controls the direction of the write current in the write line in two ways; and a current amount controller for controlling the amount of write current in the write line to a constant value, and supplying the write current to the write line,

wherein the direction of write current supplied to the first and

second write lines selected by the write logic controller is output as direction control information for controlling a current direction to the current direction controller, and the current direction controller controls the direction of write current in the write line on the basis of the direction control information.

10. A magnetic memory device according to claim 8, wherein the current direction controller includes:

a first differential switch pair constructed by first and second current switches provided for both ends of the write line and operating so that one of the first and second current switches is open and the other is close; and

a second differential switch pair constructed by third and fourth current switches provided in correspondence with the first and second current switches, respectively, and operating so that one of the third and fourth current switches is open and the other is close,

the first differential switch pair has the function of selecting one of both ends of the write line as a write current inflow side, and the second differential switch pair has the function of selecting the other one of the both ends of the write line as a write current outflow side.

11. A magnetic memory device according to claim 10, wherein the current direction controller includes a differential controller for performing a control so that the first and fourth current switches are in the same

open/close state, and the second and third current switches are in the state opposite to the state of the first and fourth current switches.

12. A magnetic memory device according to claim 5, wherein magnetic fields generated by the write current flowing in the parallel portion of the first and second write lines are applied to the magneto-sensitive layer so as to be in the same direction in the memory cell to be written.

13. A magnetic memory device according to claim 12, wherein the magnetoresistive device is disposed in an area where a magnetic field is generated only in a direction orthogonal to the parallel portion, in the parallel portion.

14. A magnetic memory device according to claim 1, wherein the magnetoresistive device further comprises a stacked body including the magneto-sensitive layer, and

an toroidal magnetic layer is provided on one of the faces of the stacked body, the toroidal magnetic layer using a direction along the stacked face as an axial direction, and the parallel portion of the first and second write lines penetrating the toroidal magnetic layer along the axial direction.

15. A magnetic memory device according to claim 1, wherein magnitudes of the magnetic fields generated by the write current supplied

to the first and second write lines are equal to each other.

16. A method of writing a magnetic memory device comprising: a read line to which read current is passed; first and second write lines extending so as to cross each other, and a magnetoresistive device having a magneto-sensitive layer whose magnetization direction changes according to a magnetic field generated by write current supplied to the first and second write lines, comprising the steps of:

disposing the first and second write lines separately from the read line and enabling write current to be passed in two ways;

forming at least one of the first and second write lines in a loop shape including first and second portions connecting a bent portion and both ends;

providing a parallel portion in which the first and second write lines extend parallel with each other by bending at least one of the first and second write lines and making the first and second write lines cross each other;

disposing the magnetoresistive device in the parallel portion;

supplying write current to the first and second write lines so that both of the write currents flowing in the first and second write lines in the parallel portion are in one of first and second directions corresponding to write information; and

writing information by changing the magnetization direction of the magneto-sensitive layer by a magnetic field generated by the write

currents.

17. A method of writing a magnetic memory device according to claim 16, wherein two magnetoresistive devices are disposed in a pair of the parallel portions,

write current is supplied to the first and second write lines so that the directions coincide in each of the pair of parallel portions and the directions in the pair of parallel portions are opposite to each other, thereby changing the magnetization directions of magneto-sensitive layers of the two magnetoresistive devices so as to be anti-parallel with each other, and

information is written by using the two magnetoresistive device as one memory cell.

18. A method of writing a magnetic memory device according to claim 17, wherein both of the first and second write lines are formed in a loop shape,

the first and second portions of one of the first and second write lines are bent in a rectangular wave shape or a trapezoid wave shape so that their bending directions coincide with each other, four parallel portions are provided in a pair of first and second write lines,

a pair of magnetoresistive devices are disposed in two parallel portions provided in the first portion, thereby constructing a memory cell belonging to a first group,

a pair of magnetoresistive devices are disposed in two parallel

portions provided in the second portion, thereby constructing a memory cell belonging to a second group,

write current is supplied to the pair of first and second write lines so that current flows in the same direction in the first and second write lines in both of the two parallel portions and, moreover, current flows in opposite directions in the two parallel portions in a memory cell to be written as one of two memory cells belonging to the first and second groups, and

write current is supplied to the first and second write lines so as to flow in opposite directions in both of the two parallel portions in the other cells,

thereby changing a magnetization direction of each of the magneto-sensitive layers only in the pair of magnetoresistive devices in one of the memory cells, and selectively writing information.

19. A method of writing a magnetic memory device according to claim 16, wherein write current is supplied to a write line formed in a loop shape as one of the first and second write lines while controlling the direction of write current by selecting one of both ends as a write current inflow side and selecting the other end as an outflow side, and controlling so that the write current flows on the write lines with a predetermined current value.

20. A method of writing a magnetic memory device according to claim 16, wherein information is written by supplying write current to the first

and second write lines and applying magnetic fields in the same direction to the magneto-sensitive layers.

21. A method of writing a magnetic memory device according to clam 20, wherein magnitudes of the magnetic fields applied to the magneto-sensitive layer are equalized.